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PREY OF BREEDING CHILEAN HAWKS (*ACCIPITER CHILENSIS*) IN AN ANDEAN *NOTHOFAGUS* FOREST IN NORTHERN PATAGONIA

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ABSTRACT.—We quantified the diet of the Chilean Hawk (*Accipiter chilensis*) by analyzing 495 prey remains collected during two breeding seasons (2001–2002 and 2002–2003) in an Andean *Nothofagus* forest of Nevados de Chillán, northern Patagonia. The diet was almost exclusively birds (97.8% of all prey remains), with relatively few rodents (1.6%) and insects (0.6%). At least 19 vertebrate species composed the prey remains (1 small mammal and 18 bird species), with Austral Thrush (*Turdus falcklandii*), White-crested Elaenia (*Elaenia albiceps*), Black-chinned Siskin (*Carduelis barbata*), Fire-eyed Diucon (*Xolmis pyrope*), and Thorn-tailed Rayadito (*Aphrastura spinicauda*) being the most common. All identified vertebrate prey are known to use forest habitats; 47% ($n = 9$) are forest specialists. Prey that inhabit both forest and shrublands accounted for 82% of the remains, and 18% of prey remains were of forest specialists. Our results indicate that during the breeding season, Chilean Hawks in Nevados de Chillán are pre-eminent, bird-eating predators that feed primarily on forest-dwelling birds.
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The loss of old-growth, native forests is the most serious threat to the flora and fauna of the Patagonian temperate forest region (Fuentes 1994). The endemic, forest-specialist fauna—including various raptors (Jaksic and Jiménez 1986, Stotz et al. 1996)—is the most critically threatened (Willson et al. 1994, Kelt 2001). However, the secretive behavior and low population densities of forest raptors, and the complexity of their habitats, make them very difficult to study (Thiollay 1996, Bierregaard 1998). With the exception of the Rufous-legged Owl (*Strix rufipes*; Martínez and Jaksic 1996, 1997; Díaz 1999), Chilean forest raptors are not well-studied. Because raptors are top-level predators and generally have large home ranges, an understanding of their ecological requirements is crucial, particularly for those that are habitat specialists (Bierregaard 1998).

The Chilean Hawk (*Accipiter chilensis*; Thiollay 1994) is one of the least studied raptors in the Patagonian temperate forest. This hawk has been listed as rare throughout its entire range (Jaksic and Jiménez 1986), although it is considered relatively common in the Cape Horn province (Venegas and Sielfeld 1998). Its populations are considered threatened due to increasing habitat loss from extensive fires, logging pressures, and hunting (Jaksic and Jiménez 1986). Most of what we know of the Chilean Hawk's biology is descriptive (e.g., Housse 1945, Johnson 1965); what is known about its habitat, feeding, breeding, and movements was summarized by Thiollay (1994). Here, we report on the Chilean Hawk's diet during the breeding season in the Andean *Nothofagus* forest of Nevados de Chillán, northern Patagonia.

METHODS

Our study was conducted in the Huemules del Niblinto Nature Sanctuary and National Reserve (36° 45′ S, 71° 29′ W; 50 km east of Chillán), located in northernmost Patagonia (36–56° S; see Vuilleumier 1985). Niblinto is a private/public wildlife area (~10,000 ha) that forms part of the Nevados de Chillán, a priority site for biodiversity conservation in Chile (Muñoz et al. 1996). The landscape around the Nevados de Chillán is rugged, composed of fairly narrow valleys and high hills (800–2,500 m elevation, ≥45° slopes). The climate is Mediterranean, characterized by dry, warm (20–30° C) summers and cold (0–10° C), wet (rainy and snowy) winters (mean annual precipitation >1,000 mm).

In February 2000, we began an ecological study of high-Andean and forest raptors of

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Nevados de Chillán. Our objectives were to (1) determine their diets and relationships to prey abundance, (2) describe their breeding biology, and (3) study their hunting behavior. We studied the diet of breeding Chilean Hawks from prey remains collected during the austral summers of 2001–2002 and 2002–2003 at two nest sites (A and B; 7 km apart) located along the Niblinto river valley. This valley is dominated by shrublands and second-growth, mixed-deciduous forest composed of *Nothofagus dombeyi*, *N. obliqua*, *N. alpina*, and *Podocarpus saligna*. The older trees can reach 20–30 m in height and 0.5–1.1 m in diameter; canopy cover ranges from 50 to 85%. The midstory is composed principally of native bamboo (*Chusquea* spp.; 2–3 m tall) and dispersed shrubs (e.g., *Luma apiculata*, *Ribes magellanica*, *Azara lanceolata*, *Fuchsia magellanica*; 1–2.5 m tall). The understory is composed of diverse herbs, shrubs, and tree saplings. In addition, there are many old, fallen trees (0.5–1.5 m in diameter). During the 1950s and 1960s, some forested areas were cleared by both logging and fire to create pasturelands. These previously cleared areas are now covered by dense shrublands composed of *Nothofagus* tree saplings and pioneering species of high-Andean shrubs (*Berberis* spp., *Pernettya* spp., *Baccharis* spp.). The proportions of forest and shrubland in Niblinto are about 60 and 40%, respectively.

Prey remains at nest site A were collected during 18–25 February 2002 (fledgling period), 8–10 December 2002 (incubation period), 22 January–5 February 2003 (brood-rearing period), and 7–26 February 2003 (fledgling period). At nest site B, remains were collected only during 18–25 February 2002. Each day we searched for prey remains under nests (16–18 m above ground) and under all trees considered to be potential plucking posts (10–20 m tall). We collected feathers, feet, carcasses, skulls, bills, and fur. Most samples were collected at specific locations (within a 1- to 2-m radius) and generally, remains were from one prey item. When samples contained feathers of >1 avian species, they were analyzed in the laboratory. If >1 species was identified in a sample, each was considered a separate prey remain. On each sampling day, we collected all remains found to avoid duplication in subsequent collections. Because plucked feathers that caught on branches may have been dislodged later by wind, it is probable that a fraction of our samples were duplicated. It was not possible to discriminate prey remains with respect to the sex or age of the hawk that captured them.

Remains of birds and small mammals were identified using reference material at the Zoology Institute and the Ecology and Evolution Institute, University Austral, Chile. We identified prey items to the lowest possible taxonomic category; bird species were identified by feather color, small mammals by hair color or molar structure, and insects by head capsules or elytra (according to keys in Peña 1986). Because Chilean Hawks plucked and quartered vertebrate prey at a number of plucking posts (especially large prey), our samples were not independent; therefore, a single set of prey remains could not be assumed to represent the entire individual prey item. Studies of prey remains may overestimate the numbers of birds and underestimate the numbers of smaller prey, such as lizards or insects (e.g., Watson et al. 1998); thus, we quantified dietary components as a percentage of occurrence for a given taxon (Fo) by dividing the number of remains of that taxon by the total number of prey remains for all taxa (Marti 1987). We further evaluated the diet of Chilean Hawks with respect to the preferred habitats of their prey. Prey species exclusively or primarily inhabiting forest were classified as forest specialists, and those occupying both forests and shrublands were classified as forest/shrubland dwellers.

RESULTS

We collected 495 samples of prey remains (488 at site A and 7 at site B). We identified 18 bird and 1 mammal species (Table 1). Passerines were the dominant bird prey, with Austral Thrush (*Turdus falcklandii*), White-crested Elaenia (*Elaenia albiceps*), Black-chinned Siskin (*Carduelis barbata*), Fire-eyed Diucon (*Xolmis pyrope*), and Thorn-tailed Rayadito (*Aphrastura spinicauda*) being the most common (Table 1). The occurrence of rodents (1.6%) and insects (0.6%) in the diet was negligible. Of the 19 vertebrate prey identified to species, 47% ($n = 9$) were forest specialists and 53% ($n = 10$) inhabit both forests and shrublands (Table 1). By occurrence, the

TABLE 1. Diet of breeding Chilean Hawks (*Accipiter chilensis*) based on prey remains collected during the breeding seasons of 2001–2002 and 2002–2003 from two nest sites in an Andean *Nothofagus* forest, Nevados de Chillán, northern Patagonia. Fo = percentage of occurrence, *n* = number of prey remains.

Prey species	Mass (g)[a]	Habitat[b]	Fo (*n*)
Mammals			
Abrothrix longipilis	30	F	1.0 (5)
Unknown Sigmodontinae			0.6 (3)
Birds			
Enicognathus ferrugineus	170	F	0.2 (1)
Picoides lignarius	42	F	1.0 (5)
Colaptes pitius	330	F, S	0.4 (2)
Cinclodes patagonicus	50	F, S (A)	0.2 (1)
Aphrastura spinicauda	11	F	3.0 (15)
Leptasthenura aegithaloides	9	F, S	0.2 (1)
Pygarrhichas albogularis	23	F	1.8 (9)
Unknown Furnariidae			0.4 (2)
Pteroptochos castaneus	110	F	1.8 (9)
Scelorchilus rubecula	60	F	2.0 (10)
Scytalopus magellanicus	12	F	0.2 (1)
Unknown Rhinocryptidae			1.4 (7)
Xolmis pyrope	36	F, S	6.7 (33)
Elaenia albiceps	16	F, S	17.0 (84)
Colorhamphus parvirostris	11	F	0.2 (1)
Unknown Tyrannidae			0.8 (4)
Troglodytes aedon	10	F, S	0.4 (2)
Turdus falcklandii	87	F, S	18.4 (91)
Curaeus curaeus	90	F, S	0.4 (2)
Phrygilus patagonicus	38	F, S	1.8 (9)
Carduelis barbata	15	F, S	7.1 (35)
Unknown Fringillidae			1.8 (9)
Unknown Passeriformes			27.0 (133)
Other, unknown birds			3.6 (18)
Insects			
Aeshna spp.			0.2 (1)
Coleoptera			0.4 (2)
Total prey remains			495

[a] Weights for *E. ferrugineus*, *C. pitius*, *C. patagonicus*, *P. albogularis*, and *S. magellanicus* were given by R. P. Schlatter (pers. comm.); weights for remaining species were taken from Jiménez and Jaksic (1989) and Egli (1996) for birds, and from unpublished data of the authors for small mammals.
[b] Habitat types from Rozzi et al. (1996) for birds and from the authors' unpublished data for small mammals: A = aquatic, F = forest, S = shrubland.

forest/shrubland dwellers were the most common prey (Fo = 82%); the remaining 18% were forest specialists.

DISCUSSION

The Chilean Hawk has been described as a bird-eating predator (Housse 1945, Johnson 1965). Our finding that birds—the Austral Thrush in particular—constitute the main prey of the Chilean Hawk concurs with a previous report by Housse (1945). Although the Chilean Pigeon (*Columba araucana*) has been described as one of the Chilean Hawk's main prey species (Johnson 1965), no pigeon remains were found in our collections, due, perhaps, to the low abundance of Chilean Pigeons at our study site (<1% of all counted birds; RAFR unpubl. data) and/or to the fact that we collected most prey remains from only one nest site. Our finding of various rodents among prey remains contradicts a previous assertion that the Chilean Hawk is strictly a bird-eating raptor (Housse 1945, Johnson 1965) and supports Figueroa et al. (2001), who reported yellow-nosed field mouse (*Abrothrix xanthorhinus*) in the diet of Chilean Hawks in *Nothofagus* forests of Tierra del Fuego. Although lizards are relatively

common in our study area, we did not find lizard remains among our samples—most likely because lizards are consumed whole by Chilean Hawks (as we occasionally observed after this study). During February 2004 near nest site A, SCS observed a juvenile Chilean Hawk capture and swallow a lizard whole (*Liolaemus* spp., 13–14 cm length).

The most common prey items in the Chilean Hawks' diet appeared to represent the most abundant species at our study site. Thorn-tailed Rayadito, White-crested Elaenia, Black-chinned Siskin, and Austral Thrush accounted for 13, 12, 6.5, and 5%, respectively, of all individual birds counted in two point-count plots established around nest site A (RAFR unpubl. data). This may indicate that Chilean Hawks capture prey species in proportion to their local abundances; however, we could not test this possibility statistically because we studied only one nesting area. The Austral Thrush may have been captured preferentially because of its large body size (see Table 1). The White-crested Elaenia actively moves among branches when foraging, which may increase its detectability and, perhaps, its vulnerability to predation. It is not surprising that Chilean Hawks preyed on species inhabiting canopy or midstory layers because the hawks also occupy those layers; we were, however, surprised to find that these hawks also forage on ground-dwelling species (e.g., rhinocriptids). On most occasions, we observed Chilean Hawks moving with agility through and under the dense thickets of native bamboo inside the forest, thus demonstrating their ability to maneuver through dense habitats.

The diet of Chilean Hawks in our study area was very similar to that reported for the closely related Bicolored Hawk (*Accipiter bicolor*). In tropical forests of Guatemala, Thorstrom and Quixchán (2000) found that 95% of the identified prey delivered to nests was composed of birds, primarily passerines. Like the Chilean Hawk, the Bicolored Hawk in Guatemala ate rodents in small amounts (3%); in the Amazonian forest of Perú, Robinson (1994) reported at least 13 bird species and 1 squirrel species in the diet of Bicolored Hawks. In the southern temperate forest, the Chilean Hawk appears to take more birds than some other Falconiformes; for example, in a *Nothofagus* forest of southern Chile, the diet composition of breeding Rufous-tailed Hawks (*Buteo ventralis*) was more evenly composed of birds and mammals (55 and 40%, respectively; Figueroa et al. 2000). In *Nothofagus* forests of southern Argentina, breeding White-throated Hawks (*B. albigula*) also had a more generalized diet, including not only birds but rodents and reptiles as well (Trejo et al. 2004). These comparisons, however, should be viewed with caution because each study entailed different methods of quantifying diet.

Increasing forest fragmentation in Patagonia may have detrimental effects on the diversity and composition of forest-dwelling species (Willson et al. 1994, Rau and Gantz 2001); in turn, this may have a negative effect on the availability of potential prey for forest-dwelling raptors. The Chilean Hawk should be given high priority in future studies to better understand its role and ecology in forest habitats.

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